

Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A heat exchanger comprising:

- a. a manifold layer having a first plurality of openings for providing a cooling material to the heat exchanger and a second plurality of openings for removing the cooling material from the heat exchanger; and
- b. an interface layer coupled to the manifold layer, the interface layer having a plurality of vertically stacked routes, each route extending from one of the first plurality of openings and terminating at a corresponding one of the second plurality of openings, each route for carrying the cooling material, a cross-section of the plurality of routes substantially contained in a plane non-parallel to a heat-exchanging plane.

Claim 2 (original): The heat exchanger of claim 1, wherein each route is adjacent to another route, whereby heat can be exchanged between cooling material circulating within adjacent routes.

Claim 3 (original): The heat exchanger of claim 2, wherein each route extends from one of the first plurality of openings toward the heat-exchanging plane and then turns to extend away from the heat-exchanging plane toward a corresponding one of the second plurality of openings.

Claim 4 (withdrawn): The heat exchanger of claim 3, wherein each route is substantially U shaped.

Claim 5 (original): The heat exchanger of claim 3, wherein after a route extends from one of the first plurality of openings and before the route extends toward one of the second plurality of openings, the route extends substantially parallel to the heat-exchanging plane.

Claim 6 (original): The heat exchanger of claim 1, wherein the interface layer comprises a structural material having a thermal conductivity of at least approximately 20 W/m-K.

Claim 7 (original): The heat exchanger of claim 6, wherein the structural material comprises a semiconductor.

Claim 8 (original): The heat exchanger of claim 6, wherein the structural material comprises a metal.

Claim 9 (original): The heat exchanger of claim 6, wherein the structural material comprises a porous material that defines the plurality of routes.

Claim 10 (original): The heat exchanger of claim 9, wherein the porous material comprises a porous metal.

Claim 11 (original): The heat exchanger of claim 9, wherein the porous material comprises a silicon foam.

Claim 12 (original): The heat exchanger of claim 6, wherein the structural material exhibits anisotropic etching.

Claim 13 (original): The heat exchanger of claim 12, wherein the structural material that exhibits anisotropic etching is selected from the group consisting of micro-scale copper tubing and copper filaments.

Claim 14 (original): The heat exchanger of claim 6, wherein the structural material comprises a composite of materials.

Claim 15 (original): The heat exchanger of claim 1, wherein the cooling material comprises a liquid.

Claim 16 (original): The heat exchanger of claim 15, wherein the liquid comprises water.

Claim 17 (original): The heat exchanger of claim 1, wherein the cooling material comprises a vapor.

Claim 18 (original): The heat exchanger of claim 1, wherein the cooling material comprises a gas.

Claim 19 (original): The heat exchanger of claim 1, wherein the cooling material is air.

Claim 20 (previously presented): The heat exchanger of claim 1, wherein a cross-section of the first plurality of openings and a cross-section of the second plurality of openings lie substantially in a single plane.

Claim 21 (original): The heat exchanger of claim 1, further comprising a heat insulator between the first plurality of openings and the second plurality of openings.

Claim 22 (original): The heat exchanger of claim 21, wherein the heat insulator comprises an air gap.

Claim 23 (original): The heat exchanger of claim 21, wherein the heat insulator comprises a vacuum gap.

Claim 24 (original): The heat exchanger of claim 21, wherein the heat insulator comprises an insulating material having a thermal conductivity of approximately 5 W/m-K or less.

Claim 25 (withdrawn): The heat exchanger of claim 1, wherein a cross-sectional dimension of a route changes as it extends from one of the first plurality of openings to one of a second plurality of openings.

Claim 26 (withdrawn): The heat exchanger of claim 25, wherein a cross-sectional dimension of a route increases uniformly as it extends from one of the first plurality of openings to a corresponding one of the second plurality of openings.

Claim 27 (original): The heat exchanger of claim 1, further comprising a heat-generating device coupled to a bottom surface of the interface layer.

Claim 28 (original): The heat exchanger of claim 27, wherein the heat-generating device is formed integrally with the bottom surface of the interface layer.

Claim 29 (original): The heat exchanger of claim 27, wherein the heat-generating device is a semiconductor device.

Claim 30 (original): The heat exchanger of claim 1, wherein each route comprises a channel.

Claim 31 (withdrawn): The heat exchanger of claim 1, wherein the plurality of routes is defined by a plurality of pin fins.

Claim 32 (withdrawn): The heat exchanger of claim 31, wherein the plurality of pin fins are positioned cross-wise to the plurality of routes.

Claim 33 (original): The heat exchanger of claim 1, further comprising a pump coupled to the first plurality of openings.

Claim 34 (original): The heat exchanger of claim 1, wherein the manifold layer and the interface layer form a monolithic device.

Claim 35 (currently amended): A method of forming a heat exchanger comprising:

- a. forming a manifold layer having a first plurality of openings for providing a cooling material to the heat exchanger and a second plurality of openings for removing the cooling material from the heat exchanger; and
- b. forming an interface layer coupled to the manifold layer, the interface layer having a plurality of vertically stacked routes that each extends from one of the first plurality of openings and terminates at a corresponding one of the second plurality of openings, each route for carrying the cooling material, a cross-section of the plurality of routes substantially contained in a plane non-parallel to a heat-exchanging plane.

Claim 36 (original): The method of claim 35, wherein each route is adjacent to another route.

Claim 37 (original): The method of claim 35, wherein each route extends from one of the first plurality of openings toward the heat-exchanging plane and then turns to extend away from the heat-exchanging plane toward a corresponding one of the second plurality of openings.

Claim 38 (withdrawn): The method of claim 37, wherein each route is substantially U shaped.

Claim 39 (original): The method of claim 37, wherein after a route extends from one of the first plurality of openings and before the route extends toward one of the second plurality of openings, the route extends substantially parallel to the heat-exchanging plane.

Claim 40 (original): The method of claim 35, wherein the interface layer comprises a structural material having a thermal conductivity of at least approximately 20 W/m-K.

Claim 41 (original): The method of claim 40, wherein the structural material comprises a semiconductor.

Claim 42 (original): The method of claim 40, wherein the structural material comprises a metal.

Claim 43 (original): The method of claim 40, wherein the structural material comprises a porous material defining the plurality of routes.

Claim 44 (original): The method of claim 43, wherein the porous material comprises a porous metal.

Claim 45 (original): The method of claim 43, wherein the porous material comprises a silicon foam.

Claim 46 (original): The method of claim 40, wherein the structural material exhibits anisotropic etching.

Claim 47 (original): The method of claim 46, wherein the structural material exhibiting anisotropic etching is selected from the group consisting of micro-scale copper tubing and copper filaments.

Claim 48 (original): The method of claim 40, wherein the structural material comprises a composite of materials.

Claim 49 (previously presented): The method of claim 35, wherein a cross-section of the first plurality of openings and a cross-section of the second plurality of openings lie substantially in a single plane.

Claim 50 (original): The method of claim 35, further comprising forming a heat insulator between the first plurality of openings and the second plurality of openings.

Claim 51 (original): The method of claim 50, wherein the heat insulator comprises an air gap.

Claim 52 (original): The method of claim 50, wherein the heat insulator comprises a vacuum gap.

Claim 53 (original): The method of claim 50, wherein the heat insulator comprises a material having a thermal conductivity of approximately 5 W/m-K or less.

Claim 54 (withdrawn): The method of claim 35, wherein a cross-sectional dimension of a route changes as it extends from one of the first plurality of openings to a corresponding one of the second plurality of openings.

Claim 55 (withdrawn): The method of claim 54, wherein a cross-sectional dimension of a route increases uniformly as it extends from one of the first plurality of openings to a corresponding one of a second plurality of openings.

Claim 56 (original): The method of claim 35, further comprising coupling a heat-generating device to a bottom surface of the interface layer.

Claim 57 (original): The method of claim 56, wherein coupling a heat-generating device to a bottom surface of the interface layer comprises integrally forming the heat-generating device to the bottom surface of the interface layer.

Claim 58 (original): The method of claim 57, wherein the heat-generating device is a semiconductor device.

Claim 59 (original): The method of claim 35, wherein each route comprises a channel.

Claim 60 (withdrawn): The method of claim 35, wherein each route is defined by a plurality of pin fins.

Claim 61 (withdrawn): The method of claim 60, wherein the plurality of pin fins are positioned crosswise to the plurality of routes.

Claim 62 (original): The method of claim 35, wherein the manifold layer and the interface layer form a monolithic device.

Claim 63 (original): The method of claim 35, wherein the step of forming an interface layer comprises patterning a semiconductor device and etching the patterned semiconductor device to form the interface layer.

Claim 64 (original): The method of claim 35, wherein the step of forming an interface layer comprises stamping a sheet of metal in the shape of the plurality of routes.

Claim 65 (original): The method of claim 35, wherein the step of forming an interface layer comprises injection molding a metal in the shape of the plurality of routes.

Claim 66 (withdrawn): A method of cooling a device comprising transmitting a cooling material from an inlet manifold, through a plurality of stacked routes positioned over the device, and to an outlet manifold.

Claim 67 (withdrawn): The method of claim 66, wherein the stacked routes comprise a structural material having a thermal conductivity of at least approximately 20 W/m-K.

Claim 68 (withdrawn): The method of claim 67, wherein the structural material comprises a semiconductor.

Claim 69 (withdrawn): The method of claim 67, wherein the structural material comprises a metal.

Claim 70 (withdrawn): The method of claim 67, wherein the structural material comprises a porous material that defines the plurality of stacked routes.

Claim 71 (withdrawn): The method of claim 70, wherein the porous material comprises a porous metal.

Claim 72 (withdrawn): The method of claim 70, wherein the porous material comprises a silicon foam.

Claim 73 (withdrawn): The method of claim 67, wherein the structural material exhibits anisotropic etching.

Claim 74 (withdrawn): The method of claim 73, wherein the structural material exhibiting anisotropic etching comprises a material selected from the group consisting of micro-scale copper tubing and copper filaments.

Claim 75 (withdrawn): The method of claim 67, wherein the structural material comprises a composite of materials.

Claim 76 (withdrawn): The method of claim 66, wherein the plurality of stacked routes comprises pin fins.

Claim 77 (withdrawn): The method of claim 66, wherein the cooling material comprises a liquid.

Claim 78 (withdrawn): The method of claim 77, wherein the liquid is water.

Claim 79 (withdrawn): The method of claim 66, wherein the cooling material comprises a vapor.

Claim 80 (withdrawn): The method of claim 66, wherein the cooling material comprises a gas.

Claim 81 (withdrawn): The method of claim 66, wherein the cooling material is air.